PLASTIC WATER BOTTLE

The invention relates to containers for fluids, and more particularly to a plastic bottle for non-carbonated beverages that resists deformation and damage during the capping process.

BACKGROUND OF THE INVENTION

Blow-molded plastic bottles for containing liquids at elevated pressures are known and have found increasing acceptance. Such containers are accepted particularly in the beverage industry as disposable containers for use with effervescent or carbonated beverages, especially carbonated soft drinks. These plastic containers can reliably contain carbonated beverages generating internal pressures as high as 100 psi or more and can be inexpensively manufactured. Typically, these plastic bottles have a cylindrical shape which reliably contain carbonated beverage products, can be easily handled, can be inexpensively manufactured, and have stability when filled and unfilled. Such containers have most frequently been manufactured from plastic materials such as polyethylene terephthalate (PET) by, for example, blow molding a portion of PET into a mold formed in the shape of the container. The biaxial expansion of PET by blow molding imparts rigidity and strength to the formed PET material, and blow molded PET can provide economically acceptable wall thicknesses, with clarity in relatively intricate designs, sufficient strength to contain pressures up to 100 psi and more, and resistance to gas passage that may deplete contained beverages of their carbonation.

One problem in plastic container design is the propensity of PET to succumb to the deleterious effects of stress cracking and crazing, which is manifested as almost imperceptible streaks in the plastic, but ultimately can become complete cracks due to stress and other environmental factors. Relatively unstretched portions of a plastic container that have low degrees of crystallinity due to the lack of biaxial expansion, such as the central bottom portion, are particularly susceptible to crazing and stress cracking. The relatively unstretched central portion of the container bottom is also frequently provided with a plurality of depending feet that are formed with distention-resistant but stress concentrating areas, and the composite effect on such areas of stress and strain due to the internal pressure of the container and external environmental factors can lead to crazing, stress cracking and container bottom failure.

One commercial cylindrical beverage container that seeks to avoid such problems is formed with a full hemispherical bottom portion and provided with a separate plastic base member fastened over the hemispherical bottom portion to provide a stable base for the container. Such containers are in common use for large multi-liter containers for carbonated beverages, even though the provision of a separate plastic base member imposes increased container height, and increased manufacturing and material costs for each container. Another commercial cylindrical beverage container that seeks to avoid such problems includes a "champagne" type base having concave, or "domed" eversion-resisting central bottom portions merging with the cylindrical container sidewalls at an annular ring which forms a stable base for the container. The central domed portion of a champagne-based plastic container generally creates clearance for the gate area of the container which is intended to resist deformation due to the internal pressure of the container but is sensitive to stress cracking. However, containers with champagne bases require a greater wall thickness in the base portion to resist the distending and everting forces of the internal pressure and form stress concentrations at the annular base-forming transition between the concave central bottom portion and cylindrical sidewall that are prone to stress cracking and rupture when the container is dropped.

More recently, hemispherical bottom portions and concave champagne-like bottom portions have been combined, in which a plurality of feet are formed in the bottom of a blow molded container. These designs frequently seek eversion-resistant concave central bottom portions formed by a plurality of surrounding feet that are interconnected by a plurality of generally downwardly convex hemispheric rib portions. Many of such container designs providing footed bottles are in commercial usage. Such container designs are still subject, in the absence of relatively thick bottom wall portions, to distention of their concave central portions due to high internal pressures that can create "rockers" and significantly increased interior container volume with lower fluid levels, all of which are unacceptable to purchasers. Efforts to increase the eversion and distention resistance of the concave bottom portions of such footed containers with thinner bottom wall thicknesses have frequently led to bottom portions including small radii of curvature and discontinuous and abrupt transitions between adjoining surfaces that provide stress concentration, crazing and stress cracking

sites. Many of these problems have been overcome by various bottom configurations such as illustrated in United States Patent Nos. 4,120,135; 4,978,015; 4,939,890; 5,398,485; 5,603,423; 5,816,029; 5,826,400; 5,934,024; and 6,276,546. The bottles disclosed in these patents are incorporated herein by reference to illustrate some examples of the type and shape of bottles that can be used in the present invention.

Much of the plastic bottle design has been directed to the carbonated bottle industry. However, the non-carbonated beverage market such as water, sport drinks, fruit drinks and the like has continued to grow. It is not uncommon that plastic bottles originally designed for carbonated beverages are used for non-carbonated beverages. However, the use of these plastic bottles has been problematic, especially during the bottling of the non-carbonated beverage. The gas in carbonated beverage exerts a force on the interior of the bottle, thus resisting the deformation or collapse of the base of the bottle during the capping of the bottle. As a result, the base and walls of the plastic bottle can be made of a thinner material, which is a significant cost savings to the manufacturer. The absence of gas in non-carbonated beverages has resulted in increased deformation and/or damage of base of the plastic bottle during the bottling process. In order to address this problem, increased wall thickness for the sidewalls and base of the plastic bottle has been used. Although the increased wall thickness of the plastic bottle reduces the incidence of deformation and/or damage of the base of the plastic bottle during the bottling process, the increased wall thickness translates into increased material costs. Plastic bottles or containers that include a plastic base attachment have also been used to address this problem. However, the use of the plastic base attachment also increases the cost of the bottle or container. Bottling manufactures that bottle both carbonated and non-carbonated beverages must now maintain additional inventory of various bottle or container configurations and thicknesses.

In view of the present state of the art for plastic beverage bottles, there is a need for a plastic beverage container that can be used for non-carbonated beverages which resists deformation and/or damage to the base and/or body of the plastic beverage container during the bottling process, and which has substantially the same material cost as standard plastic bottles used for carbonated

beverages.

SUMMARY OF THE INVENTION

The invention provides an improved container for non-carbonated beverages that overcomes the past problems associated with plastic bottles used with non-carbonated beverages. The improved container is designed to have a low cost and weight, to be manufacturable from a plastic material by molding with minimal plastic material in its walls, to have excellent stability in both filled and unfilled conditions, and to have maximal volumes with minimal heights in easily handled diameters. The invention will be described with respect to the containers for non-carbonated beverages; however, the improved container can be used with non-carbonated or carbonated beverages. In addition, the present invention is applicable to containers for the bottling of liquids other than beverages (e.g., food products other than beverages, cleaning products, automotive products, paint products, etc.). Furthermore, the container will be described as being principally made of plastic material; however, the container can be formed of other materials (e.g., glass, metal, polymers and/or co-polymers other than plastic, etc.). The improved plastic container includes a neck portion, a sidewall portion and a lower bottom-forming portion. The body and/or base of the improved plastic container can be formed and/or configured to resemble configurations commonly used in prior art plastic bottles for carbonated and non-carbonated beverages. In one embodiment of the invention, the sidewall of the improved plastic container has a generally cylindrical shape; however, other shapes can be used. In one aspect of this embodiment, the sidewall can include one or more ribs to provide structural rigidity to the sidewall and/or to form a more aesthetically pleasing container design. In another and/or alternative aspect of this embodiment, the sidewall can include a region having a differing diameter than other portions of the sidewall to accommodate a label, to enhance the ability of a user to grasp the container, to provide structural rigidity to the sidewall and/or to form a more aesthetically pleasing container design. In another and/or alternative embodiment of the invention, the lower bottom-forming portion of the improved plastic container can be formed into a variety of configurations such as, but not limited to, a lower bottom-forming portion having a plurality of feet, a lower portion bottom-forming having a champagne configuration, a lower

bottom-forming portion having a substantially flat base, and the like. In one aspect of this embodiment, the lower bottom-forming portion includes hollow feet-forming portions and intervening downwardly convex, smoothly curving bottom segments which can provide, through a plastic container bottom section of minimal height, substantially maximal container volume for a given container height, a maximal cylindrical sidewall labeling height, and a lower center of gravity and wide foot print for greater container stability, when filled and unfilled, and with minimal stress concentrations and risk of stress cracking and/or other types of defects. In one design of this aspect, the improved plastic container includes a cylindrical sidewall portion and a lower bottom-forming portion having a plurality of circumferentially-spaced, downwardly convex segments extending downwardly from the cylindrical sidewall and a plurality of intervening, circumferentially-spaced, totally convex, hollow foot-forming portions that extend radially from the central bottom portion and downwardly from the downwardly convex segments to form a clearance for a concave central bottom portion. In another and/or alternative design of this aspect, the improved plastic container includes a cylindrical sidewall portion all about a central longitudinal axis, a lower bottom-forming portion including a plurality of hollow foot-forming portions extending outwardly from the central portion of the lower bottom-forming portion to form a plurality of feet, each foot-forming portion including, between said central portion of the lower bottom-forming portion and its foot, a bottom clearance-forming portion including a compound-curved offset formed by opposing radii of curvature wherein the compound-curved offset curving downwardly from said central portion about a radius of curvature below the bottom of the lower bottom-forming portion before curving about a radius of curvature above the bottom of the lower bottom-forming portion, and a plurality of smoothly curved, downwardly convex segments between adjacent pairs of hollow foot-forming portions, each of said downwardly convex segments extending upwardly between said adjacent hollow foot-forming portions and, generally expanding outwardly at its upper end to merge into said cylindrical sidewall portion. In another and/or alternative aspect of this embodiment, the lower bottom-forming portion includes a plurality of ribs extending from the sidewall to a central portion of the lower bottom-forming portion where the ribs intersect. The upper curvilinear surface of the

ribs lies on an essentially hemispherical curve in the interior of the container. In one design of this aspect, the lower bottom-forming portion includes a plurality of uniquely designed feet which extend along a curved path from the sidewall, have end walls connected to adjacent ribs and include a generally horizontal base surface. This configuration of the lower bottom-forming portion depicts a pseudo-champagne appearance wherein the feet contain a substantially vertical inner surface or lip positioned radially inwardly from the base surface and connected to a second inner surface which extends from the substantially vertical lip to the central portion of the bottom structure. Thus, the inner surfaces of the feet define a pseudo-champagne dome below the central portion and below the hemispherical bottom contour defined by the upper rib surfaces. In yet another and/or alternative aspect of this embodiment, the lower bottom-forming portion includes an essentially hemispherical curve in the interior of the container. This configuration of the lower bottom-forming portion depicts a champagne appearance. In still another and/or alternative embodiment of the invention, the improved plastic container includes an upper mouth-forming portion adapted to receive a fluid and a cap to cover the upper mouth. The design and configuration of the mouth opening can be generally the same as used in prior art plastic bottles used for carbonated beverages; however, it can be different. In one aspect of this embodiment, the opening in the upper mouth-forming portion is substantially circular. In another and/or alternative aspect of this embodiment, the upper mouth-forming portion includes one or more threads that are adapted to receive a cap. The one or more threads have a configuration that is generally the same as the threads used on prior art plastic bottles; however, it can be different. In yet another and/or alternative embodiment of the invention, the upper mouth-forming portion includes an anti-rotation flange adapted to inhibit or prevent the improved plastic container from rotating when a cap is inserted onto the upper mouth-forming portion. In one aspect of this embodiment, the anti-rotation flange is also adapted to at least partially support the improved plastic container as the improved plastic container is conveyed to and/or from the bottle filling location.

In another and/or alternative aspect of the present invention, the anti-rotation flange on the improved plastic container includes a non-circular configuration that is at least partially engagable

with one or more components of a capping machine, and wherein upon at least partial engagement with the one or more components of the capping machine, the non-circular configuration resists or prevents rotation of the improved plastic container when a cap is inserted on the upper mouth-forming portion of the improved plastic container. In prior bottling operations, prior art plastic bottles were prevented from rotating during the capping process by using a sharp implement to engage a portion of the prior art plastic bottle (e.g. circular flange, bottle base, etc.) to prevent rotation of the plastic bottle. One such device is disclosed in United States Letters Patent No. 4,939,890, which is incorporated herein by reference. The use of the sharp implement typically disfigured the prior art plastic bottle and made the prior art plastic bottle less aesthetically pleasing to consumers. The sharp implement could also damage some prior art plastic bottles during the capping process, thereby resulting in the bottles having to be destroyed. Other prior bottling operations used an anti-rotation plate that engaged the base of the prior art bottle to prevent rotation of the prior art bottle during capping. Some of these devices are disclosed in United States Letters Patent Nos. 4,120,135; 4,143,754; 4,280,612; 5,398,485; 5,816,029; 5,826,400; and 5,934,042, which are incorporated herein by reference. However, for non-carbonated beverages, the base of the plastic bottle tends to be more susceptible to deformation or damage by an anti-rotation plate. This is believed to be the result of the lack of carbonation in the fluid in the plastic bottle, which carbonation exerts a pressure force on the inside of the plastic bottle during the capping process thereby resisting deformation or damage by an anti-rotation plate. Non-carbonated beverages do not have the carbonated pressure, thus the prior art plastic bottle is more susceptible to deformation or damage to the base by an anti-rotation plate. The use of the anti-rotation flange on the improved plastic container eliminates the need for use of a sharp implement and/or use of an anti-rotation plate during the capping process. As such, deformation and/or damage to the base of the improved plastic container during the capping process in reduced or eliminated. In one embodiment of the invention, the anti-rotation flange includes a plurality of substantially straight surfaces positioned about at least a portion of the anti-rotation flange. In one aspect of this embodiment, the anti-rotation flange includes an odd number of straight surfaces. In one particular, non-limiting design, the plurality of

substantially straight surfaces have substantially the same length. In another and/or alternative particular, non-limiting design, the plurality of substantially straight surfaces form a polygonal shape (e.g. pentagon, heptagon, nonagon, etc.). In another and/or alternative embodiment of the invention, the anti-rotation flange includes at least one notch. In one aspect of this embodiment, one or more sides of at least one notch is a substantially straight surface. In one particular, non-limiting design, all the sides of at least one notch are formed by substantially straight surfaces. In another and/or alternative aspect of this embodiment, one or more sides of at least one notch is formed by an arcuate surface. In one particular, non-limiting design, all the sides of at least one notch are formed by an arcuate surface. In still another and/or alternative aspect of this embodiment, the anti-rotation flange includes a plurality of notches. In one particular, non-limiting design, the plurality of notches are substantially symmetrically oriented about the anti-rotation flange. In yet another and/or alternative aspect of this embodiment, the size and/or shape of two or more of the notches are substantially the same.

In still another and/or alternative aspect of the present invention, the anti-rotation flange on the improved plastic container includes a non-fully circular configuration that resists or prevents the improved plastic container from disengaging from a guide railing as the improved plastic container is conveyed to and/or from the bottle filling location. During the bottling process, the empty improved plastic containers are conveyed to a bottle filling location. The improved plastic containers are generally conveyed to the bottle filling location by a railing system wherein the flange on the upper mouth-forming portion of the improved plastic containers rests on the top of the railing and/or is at least partially guided by the railing. The improved plastic containers are typically moved along the railing to the bottle filling location by blowing air on the improved plastic; however, other mechanisms can be used to move the improved plastic containers along the rails. After the improved plastic container has been filled at the bottle filling location, the flange may be used to convey and/or at least partially guide the filled improved plastic container from the bottling location by another rail system. In prior art plastic bottles, the flange was circular. The circular flange did not allow the prior art plastic bottle to fall through the railing even when the plastic bottle rotated as the plastic

bottle was conveyed along the railing. The anti-rotation flange on the improved plastic container is substituted for the standard fully circular flange on prior art plastic containers. The anti-rotation flange is configured to resist or prevent the improved plastic container from disengaging from or falling through the rail system as the improved plastic container is conveyed to and/or from the bottle filling location. As such, the improved plastic container can be used on existing plastic bottling lines without having to modify the conveying system for the improved plastic container to and/or from the bottle filling location.

In yet another and/or alternative aspect of the present invention, the anti-rotation flange of the improved plastic container includes a non-fully circular configuration that enables the improved plastic bottle to be supported at the bottle filling location as a cap is inserted onto the mouth of the improved plastic container. During prior capping processes, the capping machine exerted a downward force on the cap as the cap was inserted onto the mouth of the improved plastic container. Typically, the cap was threaded onto the upper mouth-forming portion of the improved plastic container as a downward force was being applied to the cap; however, other techniques were used to insert the cap on the improved plastic container. This downward force could result in the base of the improved plastic container becoming deformed and/or damaged during the capping process. When carbonated beverages were inserted into the improved plastic container, the carbonated gas exerted a force on the inside surfaces of the improved plastic container that reduced or prevented deformation and/or damage to the base of the improved plastic container during the capping process. During the bottling of non-carbonated beverages, the lack of carbonated gas resulted in the base of the improved plastic container being more susceptible to deformation and/or damage during the capping process. Some bottle manufactures attempted to overcome this problem by inserting a protective cap on the base of prior art plastic bottles. Although the protective cap was effective in reducing the incidence of deformation and/or damage to the base of these prior art plastic bottles during the capping process, the use of the cap increased material costs of the plastic bottle and typically required some modification to the bottling line in order to properly convey the plastic bottle to and/or from the bottle filling location. In one embodiment, the anti-rotation flange is designed

such that a support plate on the capping machine can be at least partially inserted under the anti-rotation flange during the capping process such that the downward force applied to the cap during the capping process is partially or fully countered by the support plate. As a result, a reduced amount of force is exerted on the base of the improved plastic container during the capping process which results in the reduction or elimination of deformation and/or damage to the base of the improved plastic container. In one aspect of this embodiment, the support plate is positioned such that when the anti-rotation flange is supported by the support plate, the base of the improved plastic container is suspended as the cap is at least partially inserted on the mouth of the improved plastic container. As such, prior art anti-rotation wear plates are not required. In one particular design, the support plate includes a side face that at least partially engages one or more side surfaces of the anti-rotation flange so as to at least partially resist rotation of the improved plastic container while the cap is at least partially inserted on the improved plastic container.

The principal object of the present invention is to provide an improved plastic container that resists deformation and/or damage during the capping and/or filling of the improved plastic container with a fluid.

Another and/or alternative object of the present invention is to provide an improved plastic container that can be filled with non-carbonated fluids and/or carbonated fluids.

Yet another and/or alternative object of the present invention is to provide an improved plastic container that includes an anti-rotation flange.

Still another and/or alternative object of the present invention is to provide an improved plastic container that can be used in standard bottling facilities.

These and other advantages will become apparent to those skilled in the art upon the reading and following of this description taken together with the accompanied drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference may now be made to the drawings, which illustrate various embodiments that the invention may take in physical form and in certain parts and arrangements of parts wherein:

FIGURE 1 is a partial plan view of a bottling machine employing the rear container guide

assembly of the present invention;

FIGURE 2 is a cross-sectional elevation view taken along line 2-2 of FIGURE 1;

FIGURE 3 is a partial plan view of bottle support plate and guide rail in accordance with the present invention;

FIGURE 4 is a cross-sectional elevation view taken along line 4-4 of FIGURE 3;

FIGURE 5 is an exploded perspective view showing the support plate, the anti-rotation flange of a bottle and the cap for the bottle;

FIGURES 6A and 6B are partial plan views of the position of the anti-rotation flange of a bottle in the support plate;

FIGURE 7 is a partial plan view of the anti-rotation flange of two bottle being conveyed along a guide rail; and,

FIGURES 8A-8E are plan views of various non-limiting configurations of the anti-rotation flange.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings wherein the showing is for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting the same, FIGURES 1 and 2 show various portions of what is defined as a bottling machine 10. The bottling machine as defined herein includes the filling and/or the capping bottling equipment. The filling equipment is that which fills containers with product, such as, but not limited to, a non-carbonated beverage. The capping equipment is that which applies a cap, crown or other closure to the container.

Bottling machine 10 includes a rotatable star wheel 20 and a rear container guide assembly 40 spaced radially outwardly from rotatable star wheel 20 for retaining the bottles 160 within rotatable star wheel 20. Depending upon the application of bottling machine 10, an additional star wheel (not shown) or conveyor (not shown) is mated to rotatable star wheel 20 at a fixed entry point (not shown) on rotatable star wheel 20. Bottles 160 are rotated out of rotatable star wheel 20 at a fixed exit point 42 to an outfeed star wheel (not shown) or conveyor (not shown) leading to further processing or handling equipment.

FIGURE 2 illustrates a capping machine having capper head 150 for placing a closure 180 on bottle 160. Rotatable star wheel 20 essentially comprises a hub 22 secured to a vertically extending drive shaft 24 which rotates about a drive shaft axis 26.

Extending radially outwardly from hub 22 are a plurality of bottle support assemblies 30. As shown, each of bottle support assemblies 30 is mounted on star wheel 20 at a bottle support station 32. Each of bottle support assemblies 30 is arranged about the periphery 28 of rotatable star wheel 20, which is generally circular. Each bottle support assembly 30 is removable from star wheel 20 through other embodiments, known in the industry.

Rear container guide 40 includes an annular rear neck guide 44 secured in a stationary manner by bolts 46 to a frame member 48. Rear neck guide 44 has a top surface 50, a bottom surface 52 and an inclined edge surface 54 which extends radially outwardly from top surface 50 to bottom surface 52. An annular neck block 56 is secured by fasteners 58 to top surface 50 of rear neck guide 44. Neck block 56 has a top surface 60 which, as shown in FIGURE 2, is adapted to be in contact with the underside 172 of anti-rotation flange 170 of bottle 160. Neck block 56 also includes an inclined edge surface 62 extending radially outward from top surface 60. Fixed rear guide 40 and specifically annular neck block 56 functions to support anti-rotation flange 170 and bottle 160 by retaining bottle 160 on rotatable star wheel 20.

Star wheel 20 extends radially outwardly from hub 22 and has an annular neck portion 34 secured at its inner end to hub 22. Specifically, a neck portion top surface 36 extends radially outwardly to a neck portion edge surface 38 which is generally coaxial with drive shaft axis 26. Neck portion edge surface 38 terminates at a support plate portion 70 having a support plate top surface 72 which also extends radially outward from hub 22 and is generally parallel to top surface 36. Support plate top surface 72 extends radially outwardly to a support plate edge surface 74 which then extends downwardly to a ledge plate portion 76 having a ledge plate top surface 78 parallel to both of top surfaces 36 and 72. Top surface 78 extends radially outwardly to periphery 28 of star wheel 20.

As shown, star wheel 20 is used on large capacity bottling machines. This means that

periphery 28 is circular and shaft 24 is fitted with a single hub 22 and star wheel 20 can be used with many different sizes of bottles run on the same bottling line. Bottle support assemblies 30 for each size bottle are provided and are also capable of being removed and replaced for different size bottle applications. It will be appreciated that for smaller capacity machines or for different applications within the same bottling line, a star wheel may instead comprise a hub and star wheel portion having individual pockets within the star wheel itself that serve a function similar to bottle support assembly 30. In such an instance, individual hubs are designed and removable when it is desired to convert a line to different size bottles. It will be appreciated that in this instance, star wheel 20 is split into two halves 20A and 20B to permit installation and repair without disturbing, for instance, capper head 150 shown schematically in FIGURE 2, and further to allow ease of assembly and disassembly by reducing the weight of individual pieces. Such difference in a hub does not affect the present invention.

Bottle support assemblies 30 comprise three distinct pieces including a neck support bracket 80, a neck guide 82 and a bottom body guide 84. Neck support bracket 80 is attached to star wheel 20 with neck guide 82 attached to a top surface 86 of neck support bracket 80 and bottom body guide 84 attached to guide support 88 of neck support bracket 80.

Neck guide 82 includes a vertical standard 90 extending upwardly from top surface 86 and a bracket 92 extending perpendicular from vertical standard 90 radially outwardly. Bracket 92 includes a top surface 94, a bottom surface 96 and an inclined edge surface 98 which extends radially outwardly from top surface 94 to bottom surface 96. The top surface includes four openings 100. Anti-rotation plate or bottle support plate 102 is secured to top surface 94 of bracket 92 by hex-screws 104 and pins 106. Anti-rotation plate 102 includes two openings 108 for screws 104 and two openings 110 for pins 106, which are used to secure and position the anti-rotation plate to bracket 92. One or more anti-rotation plates can be removed from bracket 92 and replaced by simply removing the screws. As can be appreciated, other means for connecting the anti-rotation plate to the bracket in a removable or non-removable manner can be used (e.g. bolts, nails, clips, welding, soldering, rivets, adhesive, clamps, and/or the like).

Referring now to FIGURES 3-5, anti-rotation plate 102 has a top surface 112 and a bottom surface 114. Each anti-rotation plate includes a pocket 116 that is adapted to receive anti-rotation flange 170 of bottle 160. As shown in FIGURE 3, the width of the anti-rotation plate is greater at the end including the pocket than at the end including openings 108. The narrowing of the anti-rotation plate at the connection end facilitates connecting and orienting multiple anti-rotation plates on bracket 92. As can be appreciated, other configurations of the anti-rotation plate can be used to facilitate in connecting and orienting multiple anti-rotation plates on bracket 92.

The top surface of the anti-rotation plate includes a recessed region 118 that surrounds pocket 116. The top surface 120 of recessed region 118 generally lies in the same plane as top surface 112. End wall 122 is generally perpendicular to top surfaces 112 and 120. As can be appreciated, end wall 122 can be oriented non-perpendicular to top surface 120. The recessed region provides clearance for capper head 150 during the capping process. As can be appreciated, the recessed region can be eliminated from the anti-rotation plate.

Pocket 116 includes a support ledge 124 that is adapted to partially or fully support bottle 160 during the bottling and/or capping process. As such, deformation and/or damage to the bottle, such as plastic bottles, during the bottling and/or capping process in reduced or eliminated. Support ledge includes a top surface 125 generally lies in the same plane as top surface 112. Support ledge 124 is designed to receive underside 172 of anti-rotation flange 170 of bottle 160. The front face 126 of the support ledge is semi-circular in configuration and encompasses an angle of up to about 180°. The semi-circular configuration of the front face is adapted to receive the circular portion of the neck of the bottle located below the anti-rotation flange. As can be appreciated, the shape of the front face can be other than semi-circular. Extending upwardly from the support ledge and to the top surface of the recessed region is anti-rotation wall 128. The plane of the anti-rotation wall is generally perpendicular to top surface 120 and support ledge 124. As can be appreciated, the plane of the anti-rotation wall can be oriented so as to form an angle of between about 90-130° between the anti-rotation wall and support ledge 124. The top portion of the anti-rotation wall can abruptly converge with top surface 120 of recessed region 118, or have a smoother transition in the form of

a curved surface.

Anti-rotation wall 128 includes four walls 130, 132, 134, 136 that are generally straight. Walls 132 and 134 have generally the same length, as do walls 130 and 136. The angle between the walls is about 140-143°. Such an angle accommodates a anti-rotation flange on the bottle having seven equally spaced sides (e.g. heptagon). As can be appreciated, the configuration of the anti-rotation wall can include more or less walls, and/or the one or more walls can have a non-straight surface. The configuration of the anti-rotation wall is selected so as to inhibit or prevent rotation of the anti-rotation flange of the bottle during the capping process when the anti-rotation flange is positioned in pocket 116.

When the anti-rotation flange of the bottle is positioned in pocket 116 of the anti-rotation plate, top surface 60 of neck block 56 is positioned at an area diametrically opposed to pocket 116. Contact with top surface 60 coacts with anti-rotation plate 102 and functions to maintain bottle 160 within pocket 116 as star wheel 20 rotates. Pocket 116 inhibits or prevents rotation of bottle 160 when a closure 180 is tightened thereon by capper head 150.

In one particular non-limiting configuration of the pocket of the anti-rotation plate, the anti-rotation plate is made of stainless steel (e.g. 304, 316, etc.). As can be appreciated, the anti-rotation plate can be made of or include other materials. Typically the anti-rotation plate is electro-polished. The thickness of the anti-rotation plate is about 0.1875 inch. As can be appreciated, other thicknesses can be used. Openings 108 have a diameter of about 0.28 inch and openings 110 have a diameter of about 0.19 inch. As can be appreciated, other shapes and sizes of the openings can be used. Recessed region is recessed about 0.016 inch and has a radius of about 1.125 inch. As can be appreciated, other depths of the recess can be used. Alternatively, it can be appreciated that the recess can be eliminated from the anti-rotation plate. The height of anti-rotation wall is about 0.093 inch. As can be appreciated, other heights can be used. The anti-rotation wall has four walls having an angle of about 141.43° between the walls. As can be appreciated, other angles can be used and/or other numbers of walls can be used. The distance of the center of each wall from the center of pocket 116 is about 0.618 inch. As can be appreciated, other distances can be used. The front face

of support ledge 124 has a radius of curvature of about 0.531 inch. As can be appreciated, other radii of curvature can be used. As a result, the width of the support ledge from the center of each wall 130, 132, 134, 136 to front face 126 is about 0.087 inch.

As shown in FIGURE 2, bottom body guide 84 includes a body guide bottom surface 85 and a body guide upper surface 87. Bottom body guide 84 is rigidly attached to neck support bracket 80 and specifically to guide support 88. It will be appreciated that each bottom body guide 84 can have a retaining pocket (not shown) having a semi-circular cross section. As such, bottom body guide 84 contacts the sidewall of bottle 160 at an area vertically downward from pocket 116 of anti-rotation plate 102 and at an area diametrically opposed to a sidewall contact established by an annular sidewall rear guide 64 to retain bottle 160 substantially vertical while star wheel 20 rotates bottles 160 from a fixed entry point to fixed exit point 42.

Annular sidewall rear guide 64 has an inner radial surface 65 and an outer surface 66, the radius of each surface 65 and 66 terminating at drive shaft axis 26. Sidewall rear guide 64 includes an upper surface 67 and a lower surface 68. A through-sleeve extends between upper surface 67 and lower surface 68 at at least one location in sidewall rear guide 64. It will be appreciated that the relative size and relationship of rear guide 64 can remain generally constant for many size bottles since, for instance, the diameter of a one-liter, a 12-ounce and a 20-ounce bottle are generally the same. It will also be appreciated that the that rear guide 64 can be completely changed out and replaced with a different size rear guide 64. Suspended from rear neck guide 44 is at least one vertical post or positioning rod 69. The positioning rod can include circumferential concave grooves (not shown) spaced along a length between the lower end and an upper end of the vertical post. Vertical post 69 is attached to rear neck guide 44 by the hex head bolts 46. Sidewall rear guide 64 can be attached to vertical post 69 by various means. One such arrangement is disclosed in United States Letters Patent No. 5,732,528, which is incorporated herein by reference.

Referring now to FIGURES 2-8, bottle 160 is in the form of a non-carbonated beverage bottle. As can be appreciated, bottle 160 can also be used for carbonated beverages. Bottle 160 includes an upper neck and mouth-forming portion 162, a cylindrical sidewall portion 184 extending

around the longitudinal axis of the container, and a lower base-forming portion 190. The upper neck and mouth-forming portion 162 provides a neck-forming transition 164 leading to the container mouth 166. The transition portion 164 can take any conveniently usable and moldable shape such as, but not limited to, a frustoconical shape, hemispherical shape, ogive shape, or some other shape. A thread 168 positioned adjacent mouth 166 is designed to accept a threaded cap 180 commonly used to close the beverage bottles; however, the mouth-forming portion of the containers can be provided with means to accommodate other types of closures.

The upper neck and mouth-forming portion 162 also includes an anti-rotation flange positioned above the transition portion 164. The anti-rotation flange includes an underside surface 172 and a topside surface 174. Underside surface 172 is adapted to be partially or fully supported in pocket 116 of anti-rotation plate during the capping process. Underside surface 172 is also adapted to be partially or fully supported by guide rails 140, 142 when the bottle is being conveyed to and/or from the bottling and/or capping apparatus as illustrated in FIGURE 7. As shown in FIGURES 1, 3, 5-7, the anti-rotation flange has seven sides 176 that form a generally heptagonal shape. The odd number of sides inhibits or prevents the anti-rotation flange from disengaging from guide rails 140, 142 when the bottle is being conveyed to and/or from the bottling and/or capping apparatus. The sides of the anti-rotation flange also enable one or more sides of the anti-rotation flange to partially or fully mate with the anti-rotation wall in pocket 116 to inhibit or prevent rotation of the bottle during the capping process. The mating of the one or more sides of the anti-rotation flange with the anti-rotation wall in pocket 116 is illustrated in FIGURES 6A and 6B. As shown in FIGURES 6A and 6B, the anti-rotation flange is positioned in pocket 116 such that the anti-rotation flange is not ideally oriented in pocket 116. When the bottles are conveyed to the bottling and/or capping apparatus, the bottles are oriented in various positions. However, during the bottle's movement on the star wheel and/or during the capping process, the bottle will be rotated as shown by the arrows in FIGURES 6A and 6B, thereby resulting in the anti-rotation flange becoming properly oriented with respect to the anti-rotation wall in pocket 116, thus resulting in the inhibiting or preventing of further rotation of the bottle during the capping process.

Referring now to FIGURES 8A-8E, several other non-limiting configurations of the anti-rotation flange can be used on bottle 160 to inhibit or prevent rotation of the bottle during the capping process and/or inhibit or prevent the anti-rotation flange from disengaging from the guide rails when the bottle is being conveyed to and/or from the bottling and/or capping apparatus. As shown in FIGURE 8A, the anti-rotation flange has five generally equal length sides 176 thereby forming a pentagon. In FIGURE 8B, the anti-rotation flange has nine generally equal length sides 176 thereby forming a nonagon. As can be appreciated, the anti-rotation flange can be formed to have less than five generally equal length sides or more than nine generally equal length sides. When equal length straight sides are used, the number of sides typically is an odd number. As can be appreciated, when non-equal length straight sides are used, the number of sides on the anti-rotation flange can be an odd or even number. In FIGURE 8C, the anti-rotation flange includes eight notches 178 having an arcuate shape. Although a plurality of arcuate notches are shown, the anti-rotation flange can include only one notch 178 or some number other than eight. In FIGURE 8D, the anti-rotation flange includes a twelve V-shaped notches 200. Although a plurality of V-shaped notches are shown, the anti-rotation flange can include only one notch 200 or some number other than twelve. In FIGURE 8E, the anti-rotation flange includes a eight notches 202 that have a substantially straight surface and an arcuate surface. Although a plurality of notches 202 are shown, the anti-rotation flange can include only one notch 202 or some number other than eight. Many other non-circular anti-rotation flanges can be used that inhibit or prevent rotation of the bottle during the capping process and/or inhibit or prevent the anti-rotation flange from disengaging from the guide rails when the bottle is being conveyed to and/or from the bottling and/or capping apparatus. These other configurations fall within the scope of this invention.

As shown in FIGURE 2, lower base-forming portion 190 of container 160 includes a central portion 192 having a hemispherical or champagne-type configuration. As can be appreciated, lower base-forming portion 190 can have other configurations such as having a plurality of foot-forming portions (not shown) formed about the central portion for supporting bottle 160.

The bottle can be formed into a variety of dimensions to satisfy a particular use. Typically,

the bottle is sized for 16-ounce applications, 20-ounce applications, one-quart applications, one-liter applications, two-quart applications, two-liter applications, and one-gallon applications. As can be appreciated, other sized bottles can be used. For instance, a bottle for containing 20 ounces can have an overall height of about 7-9 inches, for filling within about 1.25-2 inches of the mouth. When the bottle is a plastic bottle, the upper neck and mouth-forming portion can be finished with a threaded opening (e.g. PCO-28 finish). As can be appreciated, a sports top that allows for easy opening and closing of the mouth can be additionally or alternatively inserted in the mouth of the bottle. The cylindrical sidewall of the bottle can have a maximum diameter of about 2.25-3.5 inches. A reduced label panel diameter 193 on the sidewall can be used as shown in FIGURE 2. If such panel diameter is used, the diameter can be about 2-3.25 inches. Additionally and/or alternatively, the sidewall can include one or more ribs 194 extending about the central axis of the bottle. A number of other configurations can be incorporated on the sidewall for structural and/or aesthetic purposes. The neck-forming transition between the cylindrical sidewall and the mouth can be an ogive shape extending downwardly from about 0.5-1.5 inch below the mouth of to blend into the cylindrical sidewall approximately 2-3.5 inches below the mouth. The base of the bottle can be substantially flat, convex, and/or include a plurality of feet or legs. If the bottle is a plastic bottle that includes feet or legs, such configuration can be the same or similar to configurations disclosed in United States Patent Nos. 4,978,015; 5,603,423; and 6,276,546, which are incorporated herein by reference.

In another example, a bottle for containing two liters can have an overall height of about 10-13 inches, for filling within about 1-2.25 inches of the mouth. The finish of the bottle, when made of plastic, can be a threaded opening with a PCO-28 finish. The cylindrical sidewall of the improved bottle can have a maximum diameter of about 3.5-5 inches. A reduced label panel diameter on the sidewall can be used. If such panel diameter is used, the diameter can be about 3.25-4.75 inches. Additionally and/or alternatively, the sidewall can include one or more ribs extending about the central axis of the bottle. A number of other configurations can be incorporated on the sidewall for structural and/or aesthetic purposes. The neck-forming transition between the cylindrical sidewall and the mouth can be an ogive shape extending downwardly from about 0.5-1.5 inch below the

mouth to blend into the cylindrical sidewall approximately 3-5 inches below the mouth. The base of the bottle can be substantially flat, convex, and/or include a plurality of feet or legs. If the improved plastic container includes feet or legs, such configuration can be the same or similar to configurations disclosed above.

Bottle 160 can be formed by a number of standard techniques. Typically, when the bottle is formed of plastic, the bottle is formed from PET; however, other plastics can be used. Generally, the processing of the plastic bottle involves the injection molding of PET into what is commonly referred to as a "preform" and then blow-molding such preform into the improved plastic container. PET is a polymer with a combination of properties that are desirable for the packaging of carbonated and non-carbonated beverages including toughness, clarity, creep resistance, strength, and a high gas barrier. Furthermore, because PET is a thermoplastic, it can be recycled by the application of heat. Solid PET exists in three basic forms, namely amorphous, crystalline, and biaxially oriented. PET in the amorphous state is clear and colorless and is only moderately strong and tough. This is the state that preforms are in upon being injection molded. Crystalline PET is formed when molten PET is cooled slowly to below about 80°C. In the crystalline state, PET appears opaque, milky-white and is brittle. Oriented PET is formed by mechanically stretching amorphous PET at above about 80°C and then cooling the material. Biaxially oriented PET is usually very strong, clear, tough, and has good gas barrier properties. Therefore, in the design of plastic containers made of PET, it is desirable to obtain as much biaxial orientation as is possible. Various types of PET material can be used in the manufacture of the improved plastic container. Typical values of intrinsic viscosity for PET bottle manufacture are in the range of about 0.65 to 0.85.

The bottle, when formed of plastic, can be formed by a conventional injection-molded preform. As known in the art, various configurations of preforms for a desired plastic bottle can be used to make various plastic bottle designs. The use of a particular preform with a particular plastic bottle design is a matter of design and the selection criteria. It may be advantageous to alter the design of the preform to optimize the final plastic bottle design. For instance, it may be advantageous to taper the bottom of the preform to allow better orientation and distribution of

material. As can be appreciated, other alterations can be used. The improved plastic container can be formed by a conventional stretch blow-molding process. In such a process, biaxial orientation is introduced into the PET by producing stretch along both the length of the improved plastic container and the circumference of the improved plastic container. In stretch blow-molding, a stretch rod is utilized to elongate the preform, and air or other gas pressure is used to radially stretch the preform, both of which happen essentially simultaneously. Prior to blow-molding, the preforms are preheated to the correct temperature, generally about 100°C, but this temperature can vary depending upon the particular PET material used. Once the PET preform is at the desired temperature, it is typically secured by its neck in a mold which has a cavity of the desired plastic container shape. A stretch rod is introduced into the mouth of the improved plastic container to distribute the material the length of the improved plastic container. Simultaneously, air can be blown into the improved plastic container from around the stretch rod to distribute the material radially to give the radial or hoop orientation. Air pressure pushes the improved plastic container walls against the mold, which is generally cooled, causing the PET to cool. After sufficient cooling has taken place, to avoid plastic bottle shrinkage, the mold is opened and the improved plastic container is discharged.

The invention can thus provide durable bottle for carbonated and non-carbonated beverages. When the bottle is formed of plastic, the plastic bottle can be formed at a low cost and low weight manufacturable from plastic material by molding with minimal plastic material, with maximal volumes with minimal heights in easily handled diameters, with maximal height cylindrical sidewall portions, with excellent stability in both filled and unfilled conditions.

The present invention has been described with reference to a number of different embodiments. It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials or embodiments shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art. It is believed that many modifications and alterations to the embodiments disclosed will readily suggest themselves to those skilled in the art upon reading and understanding the detailed description of the invention. It is

intended to include all such modifications and alterations insofar as they come within the scope of the present invention.